# BACOT, A MARTYR TO SCIENCE

By ARTHUR H. SMITH, Ph. D.
YALE UNIVERSITY

ABOVE one of the portals in Memorial Hall at Yale is the inscription, "We who must live salute you who have found strength to die." This sentiment is dedicated to those students who gave their lives on the battle field for their country. No village or hamlet in this or any other country is too small to have a monument to its soldier dead. Romance, fearless heroism and tender memories crystallize out of wholesale human combat. But there have been other struggles which have claimed their share of human interest—spiritual contests, strife against fear and superstition and struggles against disease and pestilence.

The advance of civilization has been made quite as often by individual effort as by group endeavor. In the history of progress in medicine we have countless instances of men who have unselfishly spent their efforts in study and tireless experimentations for the advancement of knowledge. And then we have those selfless souls who have given not only their efforts but their lives in the struggle for mastery over ignorance and disease.

The story of the conquest of yellow fever must always bring to mind the brave group of army surgeons who carried on their experiments among the mosquito-infested swamps of Cuba immediately after the Spanish-American war. One of the men, Dr. Jesse W. Lazear, died with yellow fever, contracted through the bite of a stray infected mosquito which he refrained from killing in order to study its method of attack and because he feared to disturb the patient on whom he was working. That fact is stranger than fiction is brought home to us again in the account of the discovery that Rocky Mountain fever is transmitted from one animal to another by ticks. Through the brilliant work of Dr. H. T. Ricketts we now know that at times the adult tick accidentally bites man, thus causing spotted fever. After isolating the organism responsible for this disease, Ricketts turned his attention to typhus and discovered that this affection also was transmitted by an insect. It was while pursuing this work in Mexico that he was stricken with typhus and died. Both Lazear and Ricketts were fully aware of the virulence of the disease they were

studying, yet neither hesitated in his attack on the unknown. The fact that these men fought an intangible and elusive but none the less deadly enemy with the instruments of the laboratory and finally gained a victory for human welfare entitles them to a place among the heroes whose praises are seldom sung but upon whose achievements the comparative comfort and safety of our present life so largely rests. It is the account of the latest of these martyrs of science to which I wish to refer.

The British medical news dispatches have recently reported the death on April 12th of Arthur William Bacot in Cairo. In January, 1922, he had gone at the invitation of the Egyptian government to carry on further investigations on typhus, not as a result of a serious outbreak of the disease, but in an effort to obtain more definite information about it for preventive measures. Mr. Bacot contracted typhus while handling infected lice. The career of this professional-layman who has contributed so much to our knowledge of insect-borne diseases is worthy of special notice.

Until 1910 he was a clerk in London. On Saturday afternoons and on Sundays he crept away from his drudgery out of the city into the country and pursued the study of entomology with passionate zeal. Apparently he developed his powers for careful, detailed observation on these week-end trips, for one of his early discoveries was that the eggs of gnats will not hatch in absolutely clean water. He became known as an expert on the Lepidoptera and published accounts of his remarkable experiments upon the breeding of moths. In all of this early work there was shown evidence of a skill and fineness of technic which was to be useful to him in his later work; and the enthusiasm and freshness of outlook of the amateur became so firmly developed that his later professional entomological work was uniquely characterized by these very qualities.

Until he was past the prime of life, science was his avocation. In 1910 came his first commission of a professional nature when he assisted in the study of the bionomics of fleas for the Indian Plague Commission under the auspices of the Lister Institute. As a result of his excellent work, he was appointed to the post of entomologist of the Lister Institute, an advancement which was more than justified by his subsequent achievements.

During the next three years he played an important part in discovering the mechanism by which the plague is conveyed from rats to man by fleas. Then he went to West Africa and studied yellow fever, writing a masterful report on the bionomics of the mosquito responsible for its transmission. It is significant that he should make a distinct further advance to our knowledge of the

etiology of this disease, a subject to which American investigators have contributed much and in connection with which another martyr, Dr. Lazear, gave his life more than ten years before.

Since 1916 Mr. Bacot had focussed his attention on the biology of the louse. With remarkable attention to detail he has given us an account of the growth and moulting of the louse, length of life, method of ovulation, feeding habits, effect of temperature and food supply on activity—in short, a complete compilation of the bionomics of this insect. While these studies were in progress the experimental animals had to be fed and, since the natural habitat is the clothing next to the human skin with blood as their food, it devolved on Bacot to devise methods for keeping these lice in captivity and at the same time to feed them. During these and subsequent years he kept his colonies of stock lice in small, round cardboard boxes, one end of which was covered with chiffon so that when occasion arose, the boxes could be fastened on his arms, legs or body and the lice given opportunity to feed. Mr. Bacot realized that many insecticides were not subjected to practical tests before being advocated for use, for that which was effective in the atmosphere of a closed bell jar in a laboratory might be absolutely useless when applied under the clothing next to a moist skin at 85°. He planned and carried out experiments testing insecticides, the lice and the substance to be tested being suspended in cloth bags under his shirt next to his skin. To read, in his own words, of the matter-of-fact way in which he considered these unusual procedures is to have an insight into a type of personality which relegates self to the background and considers steadfastly the final goal of its efforts. Here, in truth, was an effective union of mind and body in service to mankind.

These studies prepared him for similar work of a more specialized nature, and in 1917 the War Office saw fit to put him on the committee for investigating trench fever. This disease had been playing havoc among the British troops. It was reported that at one time 60 per cent. of all the cases of sickness were those due to trench fever. According to another report, it caused nine tenths of all the sickness in one of the British armies. The incubation time of the organism, determined later by experiment, varies from fourteen to thirty-two days. The victim is suddenly seized with dizziness, pain in the legs, headache and pain behind the eyes while his temperature rises to 103 or 104 degrees. Skin manifestations may occur as erythematous patches. The first attack may last a week, then subside only to appear as a relapsing type at intervals of a week or more, each attack lasting from two to eight or more days. The fever may persist for as long as sixty

days with a moderately high temperature. Although the disease is rarely fatal, it is obvious that even a moderate prevalence would seriously handicap military operations.

Through the efforts of Bacot and his associates on the trench fever committee, the mystery surrounding the etiology of this affection has been cleared up. It was shown that the malady was louse-borne, that lack of opportunity to change clothing and uncertain bathing facilities incident to field conditions contributed to its spread, that a louse which had bitten a victim was capable of transmitting the disease to another person through its bite, that inoculation could be obtained by rubbing the feces or body tissues of the louse into a broken surface (as might be done in scratching), and that the dried urine of the victim was infectious. In addition, Bacot showed that in the intestinal tract and feces of lice capable of transmitting trench fever there occurred cocco-bacilli-like bodies, not stainable by the ordinary bacteriological methods, but which were similar to the rickettsia of Rocky Mountain fever. He later decided that the rickettsia of trench fever were identical with those seen in cases of relapsing fever. Such clear-cut evidence, pointing the way to very definite methods of combatting this affection, was particularly welcome at this time of stress and established Bacot in the front rank of medical entomologists, though he was not trained in medicine.

In 1920 he went to Poland as a member of the Typhus Research Commission of the League of Red Cross Societies. He took his own supply of uninfected lice which he had bred and grown in his London laboratory and which he maintained on his own person. After arriving in Warsaw several months were lost due to lack of laboratory facilities. Before active work on typhus was begun, Bacot fell sick with trench fever. During the course of his illness he kept accurate notes of his symptoms and fed lice with his blood. He observed the appearance of rickettsia in his stock lice which until his sickness had been free from them. During his convalescence and for some time afterwards, he followed the occurrence of rickettsia in the lice which he had fed and was able to show that the blood of trench fever patients when fed to lice caused the appearance of these bacteroid bodies in the lice as long as three months following the clinical recovery from the disease.

After returning to England Bacot continued his studies on infection of lice. Late in 1921, before the Royal Society of Medicine, he gave a demonstration of a method for louse infection. The procedure involved the rectal injection of blood into the louse with a capillary pipette while the insect was held under a slip of paper on the stage of a binocular microscope. All who saw it were im-

pressed by the skillful technic and dexterity shown by Bacot during the course of the demonstration. Working with these minute animals, using specially devised microtechnic, Bacot fully realized the dangers to which he was exposed because of the infectious character of the excreta of the lice, once they had fed on typhus blood. These facts serve to emphasize the high order of purpose and intensify the sacrifice he made.

An American architect recently said that the English really know how to live. If they know how to live, they also know how to play and many of them have achieved that happy combination—the proper relation of their vocation to their avocation. The typical Briton works at his stint that he may support his hobby and it is in the pursuit of the latter that he lives his life, expands his soul and produces. In the personality of Mr. Bacot we have an example of just such a balance between that which must be done and that which pleases to be done. His hobby became his ruling passion, gradually absorbed his whole life, lifted him to eminence and finally placed him among the immortals—those who have given their best that others may better live.